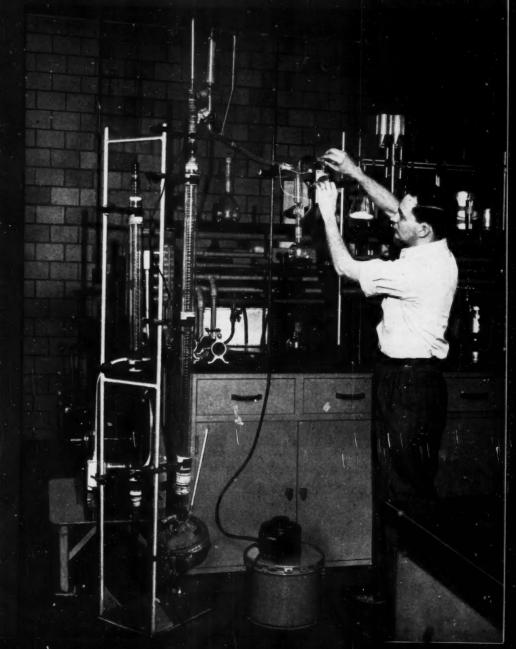
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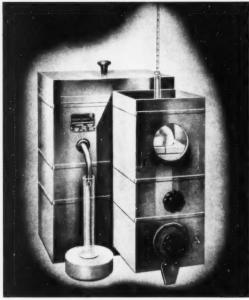




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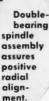
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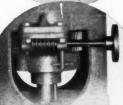


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# ABOUT THE COVER

The young chemist on the cover is performing one of the daily control tests at ARCHER-DANIELS-MIDLAND's Chemical Products plant in Wyandotte, Michigan. The apparatus with which he's working is a fatty acid fractionating column; its purpose: to determine the exact composition of a production run of one of the HYDROFOL ACIDS.

At various intervals during production, samples of HYDROFOL ACIDS are removed from process and brought to the control laboratory. There they are converted into methyl ester form, then charged into a distillation flask. Since each different chain length ester will boil at a slightly different temperature, fractional distillation of the complete HYDROFOL ACIDS will separate it into component parts. Stearic Acid can be separated from Palmitic, Behenic Acid from Arachidic, and so forth. The chemist can then accurately calculate the percentage composition of the HYDROFOL ACIDS in production.

It was the grease and stearate manufacturers who were largely responsible for ADM's Chemical Products men pioneering in the commercial production of controlled fatty acids, many years ago. At the time, the grease makers were experiencing difficulties with batches of grease being ruined due to non-uniformity. Fats and fatty acids used were being purchased on the basis of physical constants, but it became obvious that while the constants were uniform, the composition of fatty acid mixtures did vary considerably. What was needed was a fatty acid material that was uniform even to the percentages of its component parts.

(Continued on page 32)

# Presidents page

# THE N. L. G. I. FELLOWSHIP IN COLLOIDAL SCIENCE



In the March issue of The Institute Spokesman there was announcement of the establishment of the National Lubricating Grease Institute Fellowship at the University of Southern California, to promote study of scientific fundamentals which would provide for a better understanding of the structure of lubricating greases. This action marks the attainment of a long sought objective that has commanded the consideration of successive boards of directors of the Institute through several years.

It had been recognized that research carried on by company affiliated laboratories necessarily must be projected toward solution of specific problems usually related to commercial manufacture and sales. Moreover the findings of such research are rightfully the

property of the laboratory or company responsible for the development of the daia. Thus the information may not be available for wide distribution, or, because of its specific nature, might not even be useful to others in the lubricating grease industry.

Accordingly, the National Lubricating Grease Institute, representing as it does the grease manufacturing industry, has long felt an obligation to sponsor studies of fundamentals, that would be of benefit to all of the membership and to the grease manufacturing industry, the findings and conclusions of such research to be released progressively, as developed, to N.L.G.I. members. Obviously such research would be on the level of pure science, and would serve as a foundation for particularized practical and applied research leading to the development of improved lubricating greases. There is no intent of infringement, and factually there should be no infringement of the initiative of scientists in other laboratories.

The project which the N.L.G.I. is sponsoring will carry forward some investigations that have already been initiated. The Fellowship will permit expanded study of various aspects of the scientific structure and behavior characteristics of lubricating greases. Understanding of such fundamental principles will assist workers in supplementary research fields, and aid lubricating grease manufacturers in arriving at undisputed solutions to specific and individual problems.

Secondarily, it is expected that this work will stimulate the interest of other personnel trained in the field of colloidal science, who will enter the lubricating grease manufacturing industry to apply their training and knowledge to the solution of problems of formulation and manufacture.

In establishing the Fellowship in Colloidal Science, the Institute does not regard the action as a short term responsibility. It is hoped that these studies can be supported through ensuing years, and that other activities of like value to the membership can be fostered.



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# Influence of Chemical Composition of Lubricating Oil on the Manufacture of Lubricating Grease

by C. J. BONER

Battenfeld Grease & Oil Corp.

# INTRODUCTION

Looking back over the titles of papers presented at the annual meetings of the National Lubricating Grease Institute, little has been stated about the composition of the mineral oil used and its influence upon the structure of the resulting lubricating grease. Further, modern processing of lubricating oils has provided dilutents for us to work with which have different proportions of various types of hydrocarbons than were present in conventionally-refined oils. In fact, the latest lubricating oil manufacturing facilities are devoted almost wholly to solvent type oils.

It is felt that the above considerations justify an attempt to explain the effect of lubricating oil structure on the manufacture of lubricating greases.

However, we want to state that this work is not presented with the idea of going on record as recommending or condemning high VI oils in the majority of lubricating greases. You realize that most lubricating greases function over a rather narrow temperature range so that there is little justification for a flat viscosity temperature curve.

Likewise, we will not pass an opinion upon the lubricating value of the various types of oils, but will quote two authors for your consideration. Mair and Willingham (9) state: "It is possible that, in the extraction processes, one ring aromatic hydrocarbons are being discarded which may be valuable constituents of a good lubricating oil."

Kalichevsky (8) says, "As a result of solvent treatment in some instances, the improvement may be harmful for practical purposes.

# HISTORICAL

In the past, most greasemakers have found that compounding procedures had to be varied with the type of oil employed. This was particularly true if Pennsylvania oils were used in place of others.

Producers and users of aluminum stearates for bodying mineral oils have long recognized the influence of the type of oil upon the resulting lubricating grease. Thus, one manufacturer states (0): "The consistency of an aluminum soap grease depends to a marked degree on the characteristics of the oil used in manufacture. Generally, paraffinic oils produce the heaviest-bodied greases, followed by mid-continent, coastal, naphthenic, and asphaltic types in the order of decreasing gel strength. A much more common and subtle source of variation lies in the nature of the hydrocarbons which comprise the refined oil. The ratio of straight-chain (paraffinic) compounds to cyclic (naphthenic or asphaltic) compounds largely determines the behavior of an oil in greasemaking. As a rule, aluminum soaps are harder to disperse, but form stiffer gels in paraffinic hydrocarbons than in cyclics."

We find a similar statement, relative to soda base lubricating greases, by Puddington (11): "Based on the data obtained from density-temperature curves, surface tension measurements and sedimentation volumes, it could be predicted that more stable soda soap greases could be prepared with naphthene than with paraffin-base oils."

However, Puddington makes a further observation: "In contrast to soda base greases, the type of oil used in the manufacture of calcium greases had little effect on the product obtained."

This observation is not in agreement with our findings.

### LUBRICATING OILS TESTED

It was the thought that a series of oils from the same base stock would be of interest. We, therefore, appealed to a number of suppliers for samples of conventionally-refined and solvent-refined oils from the same source, the latter preferably obtained by more than one solvent process. We tried to obtain representative samples of each type of oil produced in the United States, and likewise, samples prepared by the various solvent processes in use.

A tabulation of these oils with some of their characteristics is given in Table I. We have tested lubricating oils derived from Pennsylvania, Mid-Continent, Coastal, and California crudes. In addition to conventional treatment, you will find the following solvents used: Chlorex, Duo-sol, Fur-

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None of the oils in question contained any additives, such as VI improvers.

Among the oils tested are eight series of two to four oils each. Each oil in a series is derived from the same base stock by variations in treatment.

Two polymers of butylene are also included. These represent rather definite compounds, but, of course, not of the same chemical structure as the compounds in the lubricating oils. They are included because they were the only synthetic hydrocarbons which could be obtained in experimental amounts on short notice.

### COMPOSITION OF LUBRICATING OILS

It is known that lubricating oils are hetrogeneous mixtures and that it is impractical, in fact, probably impossible at this time, to isolate or to synthesize the individual compounds so that these can be tested for their compatibility with soaps. Therefore, we will simply speculate on the general classes of compounds with which we deal. The following references give some idea of the chemical composition of lubricating oils.

vonFuchs and Anderson (14) state: "The chemical constitution of petroleum lubricating oils is regarded as being made up of three

types of hydrocarbons: paraffinic, naphthenic, and aromatic."

Mair and Willingham (9) state: "The material corresponding to the most highly refined product obtained by any good solvent extraction process consists substantially of naphthenes (cyclo-paraffins) containing from one to about three rings to the molecule together with the necessary alkyl radicals."

We also have some idea of the proportion of the various types of molecules. Thus, Thol (13) cites a certain Pennsylvania oil fraction having a mean molecular weight of 512 and consisting of 18 percent aromatic rings, 15 percent naphthene rings, and 77 percent paraffin chains; while, a certain naphthenic base oil of mean molecular weight of 349 contains 32 percent of aromatic rings, 29 percent of naphthene rings and 39 percent of paraffinic chains.

Fenske and co-workers (3) state: "The percentage of par-

affin side chains varies from 80 percent in lubricating oil from Pennsylvania crudes to 40 percent in lubricating oils from asphaltic stocks. Naphthene rings predominate in lubricating oils from paraffinic and mixed base crudes; while, in those from naphthenic and asphaltic crudes, the percentage of naphthenic and aromatic rings is approximately equal.

"The average number of rings per molecule varies from 1.5 for paraffin base lubricating oils to 4.5 for asphaltic lubricating oils, particularly naphthenic and asphaltic."

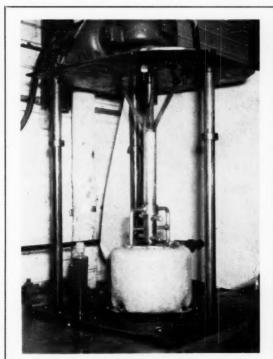
> Sachanen (12) states: "The derivatives of cyclic hydrocarbons with long-branched paraffin side chains may have very low pour points. Thus, it is obvious that the cyclic hydrocarbons of lubricating oils with paraffinic side chains of C12 or more have a branched chain structure. The degree and character of branching are entirely unknown."

Of course, the viscosity index is an indication of the proportion of the various types of chemical compounds in an oil. Even better measures are the aniline point and the viscosity-gravity constant which are included in some of the tables. The v.g.c. increases with naphthenicity, and ranges from about 0.800 for extreme paraffin types to over 0.900 for aromatics and naphthenes. The aniline points are lowest for aromatics and highest for par-

From several sources, it has been possible to tabulate with some degree of certainty (see Table II) the probable composition of

some of the oil samples with which we worked. Thus, one supplier (Kendall Refining Company) furnished the chemical composition of their samples. Carnahan (1) gives the ring analysis of several commercial lubricating oils from various sources and some of these correspond closely to the oils we used. Sachanen (12) also gives a number of such analyses of lubricating oils; and, also, vonFuchs and Anderson (14) give the ring analysis of various types of oils solvent-extracted to the same aromatic content.

Naturally, if compounds other than the hydrocarbons we have been considering were present, they would influence the dispersion of soaps. This would be particularly true of polar bodies. Fatty acids are such compounds and from the neutralization numbers of the oils used, it can be seen that they may be present in traces.



Experimental equipment used in compounding lubricants.

TABLE I - EXPERIMENTAL OILS

Oil No.	Source	Treatment	API Gravity	SSU Vis. @ 210° F.	VI	Aniline Point °F	v.g.c.	Mol. Wt.	Neut.
1	Pennsylvania	Phenol	29.0	61.5	97	230	.810	505	0.02
2	Pennsylvania	Phenol	27.5	138.8	98	259	.803	745	0.02
3a 3b	E. Texas Mixed Base E. Texas	Furfural	29.8	55.2	96.7	241	.806		0.01
	Mixed Base	Duo-Sol	29.4	70.1	96.8	251	.803		0.03
4a	Coastal	Conventional	23.1	48.0	46	182	.865	370	0.07
4b	Coastal	Furfural	26.1	50	68	206	.841	430	0.03
5a	California	Bulk Distillate	16.8	64.9	-46	143.6	.904	335	0.08
5b	California	SO <sub>2</sub> Extracted	24.3	43.6	32	174.2	.859	310	0.03
5c	California	Furfural	25.3	74.3	57	222.8	.845	448	0.02
5d	California	Furfural	27.1	73.2	70	234.7	.819	453	0.02
6a	California	H2SO Earth	18.8	52.2	-9	152	.892	314	0.02
6b	California	Phenol	23.2	49.8	30	177	.859	305	0.02
6c	California	Phenol hv. treat	25.8	54.4	57	208	.837	342	0.01
6d	California	Phenol fum. H <sub>2</sub> SO <sub>4</sub>	27.5	53.0	60	225	.825	381	0.02
7a	Mid-Continent	Chlorex	30.1	54.08	87.5	226.8	.807	495	0.03
7b	Mid-Continent	Phenol	30.0	55,34	93.1	233.2	.805	500	0.01
7c	Mid-Continent	Acid Treated	24.4	61.38	64.6	204.8	.844	470	0.04
8		Butylene-Polymer	37.3	40.25	81.5	215.8	.786	350	3.0
9a	Mid-Continent	Acid Treated	26.3	46.02	72	189.9	.838	462	0.02
9b	Mid-Continent	Phenol	28.2	45.82	80.6	199.4	.826	428	0.04
9c	Mid-Continent	Phenol hv. treat	31.0	46,6	96.5	221.8	.805	411	0.01
10a	Coastal	Conventional	24.3	44.0	45	178	.859		0.02
10b	Coastal	Phenol	27.3	44.8	62	194	.858		0.02
Ha	Mid-Continent	Chlorex	29.5	49.0	91	224.0	.814		0.01
11b	Mid-Continent	Conventional	26.5	48.0	78	196	.836		0.02
12a	Mid-Continent	Conventional	29.1	42.6	92	217.8	.826		0.03
12b	Mid-Continent	Phenol	33.7	44.1	114	230	.793		0.0
		Butylene-Polymer	35.0	52.0	82	224	.772		0.0

We do not, normally, consider lubricating oils polar, but Gallay and Puddington (4) state that they used two oils which differed widely in polarity as represented by viscosity indices of 110 and 40. In another article, Gallay, Puddington, and Tapp (15) the following statement is made: "The degree of fibrous texture is known to be dependent upon a number of factors among which are the viscosity of the oil and the polarity of the oil as represented by its viscosity index."

It must be that the aromatics in the oils are considered to have a certain amount of polarity. We find in Farkas (2) the following dipole moments listed: tuluene 0.39, tetralin 1.66. It may, thus, be that the higher molecular weight aromatic hydrocarbons of petroleum will have some polarity. SOAPS USED

Pre-formed soaps of four different bases were employed in this work. It was felt that by the use of such soaps the variables in the systems would be reduced as much as possible. These soaps, some characteristics of which are shown in Table III were:

### TYPE SOAP MAN Aluminum Stearate

Technical D
Calcium
Litholite A
Sodium Stearate,
Technical

# MANUFACTURED BY

Mallinckrodt Chemical Works Battenfeld Grease & Oil Corp. Foote Mineral Company

Mallinckrodt Chemical Works

The calcium soap was prepared from commercial tallow, containing 8.1 percent of free fatty acids. This was saponified with a slight excess of hydrated lime in the presence of water. Heat was applied and water was added until titration showed that all except the excess lime was reacted. During this period, the maximum temperature was 300°F. Approximately 0.28 percent of tallow fatty acids was used to make the mass barely alkaline. The resulting soap was a fused mass which broke readily and was as near anhydrous as could be determined.

Calcium stearate was used in a few experiments, but failure to produce satisfactory grease structure lead to discontinuing this work. Likewise, a Calcium soap was made from 42 titer animal fatty acids, but attempts to use it in the same manner as the soap from glycerides lead to so many failures that this work was not pursued.

Some work was also done with a Soda soap, known as Flint Chips, manufactured by Armour and Co. which was made from a 41 to 42 titer fatty acid. This soap contained 0.04 percent free alkali and 10 percent moisture was used. This did not prove as satisfactory for our purpose as sodium stearate.

It is recognized that a change in the fatty acid or fat constituents used in making the different metallic soaps employed very likely would cause a considerable change in the relative compatibility of any one type of metallic soap with the various oils.

### COMPOUNDING PROCEDURE

The primary aim in this work was to obtain a comparison of the ability of the soaps in question to produce a soap/oil system which had the general nature and characteristics of products marketed as commercial lubricating greases. Such a comparison, while not identical with results obtained in plant

practice, should provide some gauge as to what can be expected of mineral oils of various chemical compositions when employed for the manufacture of lubricating greases.

The compounding procedure and subsequent handling is detailed below: (All compounding was in stainless steel or glass).

Aluminum Base Products—Ten parts by weight of aluminum stearate and 90 parts by weight of the particular oil were mixed to a slurry and heated with agitation to a temperature of 300°F. The hot mixture was then placed in an oven which was heated to 225°F, a number of samples being treated at once. Heat was shut off the oven and by the next morning, the contents had reached room temperature. The samples were then transferred to a Mechanical Worker, and worked 60 strokes after which the penetration was taken.

Calcium Base Products—Ten parts by weight of the calcium soap and 30 parts by weight of mineral oil were heated to 300°F with agitation until the soap was completely dispersed. Agitation was continued without heat until the temperature reached 230°F, when, if the soap had not separated from the oil, 1.2 parts of water were added and agitation con-

TABLE II.—PROBABLE DISTRIBUTION OF COMPOUNDS IN OILS USED

Oil Number	Aromatic %	Naphthene Rings %	Paraffin Chains 9
1	7	15	78
2	3	10	87
3a	: 5	22	73
3b	5	22	73
4a	4	43	53
4b	4	41	55
5a	22	30	48
5b	7	40	53
5c	4	41	55
5d	3	39	58
6a .	14	36	50
6b	5	41	54
6c	4	41	55
6d	3	38	59
7a	3	27	70
7b	3	26	71
7c	4	27	69
8-straight c	hain polymer		
9a 1	4 :	26	70
9b	4	25	71
9c	3	22	75
10a	5	44	51
10b	4	42	54
11a	3	26	71
11b	4	36	60
12a	3	. 26	71
12b	3	24	73
13-straight cl	nala nalumar		



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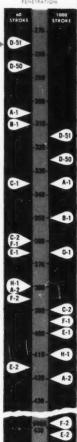
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PENETRATU



Type Soap:	Aluminum	Calcium	Lithium	Sodium
Moisture %:	0.35	0.04	0.21	1.85
Free Alkali %:		0.002	0.004	0.005
Free Fatty Acids:	6.4	(By acetone extract)		
Glycerine:		8.36		
Ash %: A1,O3	8.6			
Titer of Fatty Acids:	(*******	40.2		

tinued as the temperature dropped, until a grease structure resulted or the soap separated from the oil. If a lubricating grease resulted, 25 parts more of oil were added while mixing was continued. During this period, the temperature was maintained at 180/190°F. After standing over night, the product was worked and tested.

In case of failure to produce a satisfactory lubricating grease with a certain oil, the experiment was repeated with the addition of 0.5 parts of 42 titer fatty acids.

Lithium Base Products—Ten parts by weight of the Lithium soap and 90 parts by weight of the mineral oil were mixed and heated to a temperature of 400°F until a mass free from unmelted lumps resulted. This was then cooled in a static state until the next day when it was worked and tested.

Sodium Base Products—Ten parts by weight of sodium stearate and 90 parts by weight of oil were mixed and heated to  $380^{\circ}$ F. At this point, the soap was ordinarily dispersed in the oil, but in a few cases, it was necessary to continue heating to  $400^{\circ}$ F to obtain dispersion. The mixture was then set aside to cool in the room and worked and tested the next day.

Another series of mixtures of the above materials was made in which 9.3 parts by weight of sodium stearate, 0.9 parts by weight of 98 percent glycerine and 90 parts by weight of oil were mixed and heated. The same procedure was carried out as above.

Experimental Data—The results of the above work are shown in Table IV for Aluminum and Lithium base products, Table V for calcium base products, and Table VI for Sodium base products.

# DISCUSSION

The primary thought in this work was to determine what effect, from a manufacturing procedure, variation in the compounds making up a lubricating oil would have upon the ease of formation of a typical lubricating grease structure, and what this structure is, we make no attempt to explain.

The samples prepared, unless noted, are typical of commercial lubricating greases. The soap percentages are those which may be encountered in practice. While no tests other than consistency are reported, the other characteristics, such as dropping point, etc., are typical of the particular bases.

The effect of polar bodies cannot be avoided, but by following identical procedures, it is felt that the influence would be the same in each sample prepared. Thus, an absolutely anhydrous lubricating grease may be difficult to prepare, but by taking the same proportions of soaps and oils to the same temperature with the same agitation, etc., the final trace of moisture should be about the same.

Likewise, traces of fatty acids, beyond any shown by the neutralization number, may well be formed during compounding. Thus, Harkins (7) states: "If a drop of fresh nujol, a heavy hydrocarbon oil, is put on a clean surface of water, it does not spread, but remains as a thick lens. If the nujol has been oxidized by air by stirring in an evaporating dish over a flame, it is found to spread as a uniform polymolecular film over a considerable area."

Conceivably, the same thing may happen to the oils we employ when they are heated.

It seems logical that if polar compounds are introduced in the systems during our preparation of soap/oil systems, the same would be true in commercial practice and, thus, we have a fair comparison of the various oils.

However, we must not rule out the possibility of some slight polarity of the compounds making up the lubricating oils. Farkas (2) lists the dipole moment of some low molecular weight hydrocarbons and it would seem that where some radical interferes with the symmetrical arrangement of the molecule, slight polarity results. Thus, benzene has no dipole moment while toluene has a dipole moment of 0.39. Also, decalin has no dipole moment while tetralin has a dipole moment of 1.66. We have no proof of polarity in the lubricating oil compounds, but introduce this for thought.

### CONCLUSIONS

Aluminum Base Products—(See Table IV)—The following conclusions simply confirm what is generally known about this type of product.

(1) The lower VI oils tend to produce less brittle products, with less bleed, than the high VI oils. The exception is the Pennsylvania Bright Stock, but that is explained by the higher molecular weight of the compounds in this stock. In other words, the higher the percentage of paraffinic compounds in an oil, the greater the tendency to form brikle products with aluminum soap.

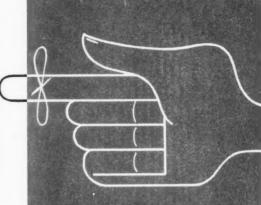
(2) The softest products were obtained with oils of low VI and the hardest product from the oil of the highest VI.

(3) Lubricating greases, of a sort, could be produced from any of the oils tested.

Calcium Base Products—(See Table V)—The following conclusions are drawn from the experiments with Calcium Soap in this series of oils.

(1) With the exception of the butylene polymers, none of the oils tested with a VI higher than 80.7 produced a lubricating grease with the calcium soap. In fact, a 78 VI oil was the most paraffinic oil which yielded a product which was not grainy.





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TABLE IV.—ALUMINUM AND LITHIUM BASE PRODUCTS

Oil			Aniline	Consistence	cies and Nature
No.	Vl	v.g.c.	Point °F	Aluminum Base	Lithium Base
1	97	.810	230	175—B slight bleed	240—O
2	98	.803	259	195	no body soap separated
3a	96.7	.806	241	190-B-C slight bleed	220—C
3b	96.8	.803	251	185—B-C slight bleed	255—C
4a	46	.865	182	200-slight bleed	200—T
4b	68	.841	206	180-B bleed	180-slightly cloudy
5a	-46	.904	143.6	250	205—slight crust on top
5b	32	.859	174.2	185—B bleed	195
5c	57	.845	222.8	185—B slight bleed	210—C
5d	70	.819	234.7	180—B slight bleed	230—C
6a	—9	.892	152	225—C	165
6b	30	.859	177	200—slight bleed	205—slight B, slight crust in bottom
6c	57	.837	208	185—B slight bleed	170—C
6d	60	.825	225	170—B bleed	175—gelled at higher temper ature than others
7a	87.5	.807	226.8	180—B slight bleed	190—C
7b	93.1	.805	233.2	210—B slight bleed	165—C
7c	64.6	.844	204.8	180—top only brittle	205—slight C
8	81.5	.786	215.8	205—C mealy	240—C slight grain
9a	72	.838	189.9	210—B slight bleed	180—soap went in at low tem perature
9b	80.6	.826	199.4	190-VB slight cloud	185—C
9c	96.5	.805	221.8	190—slightly brittle	190
10a	45	.859	178	170-VB slight bleed	170
10b	62	.858	194	170—VB	170—T
11a	91	.814	224	180—B	200—O
11b	78	.836	196	215	180—T
12a	92	.826	217.8	185—B slight bleed	170—T
12b	114	.0793	230	165—B bleed	160—O
13	82	.772	224	175—B bleed	185—O

Codes: B-Brittle O-Opaque T-Translucent C-Cloudy VB-Very Brittie

(2) With one exception, the oils with aniline points above 230 failed to produce calcium base lubricating grease, even with the addition of 0.5 percent of free fatty acids. In other words, increase in percentage of paraffinic chains increases the difficulty of formation of the type of structure normally obtained in calcium lubricating greases.

Unless noted, the products were clear, plastic, and exhibited no bleed.

Lithium Base Products—(See Table IV)—The following conclusions are drawn from our experiments with Lithium soap, in this series of oils.

- (1) A high molecular weight oil, which is also high in percentage of paraffin chains, failed to produce a grease.
- Lithium soap will tolerate a greater variation in proportions of aromatic, paraffinic and naphthenic compounds,

and still produce a lubricating grease than is true of the other soaps tested.

Sodium Base Products—(See Table VI)—The following conclusions are drawn from our experiments with Sodium base soap as bodying agents in this series of lubricating oils.

- (1) The two oils with the highest percentage of paraffinic chains failed to keep the sodium soap in suspension. On the other hand, the highest VI oil, with a somewhat smaller percentage of paraffinic chains than the oils referred to above produced a firm product.
- (2) With this specific sodium base soap, the presence of glycerine tended to cause separation of the soap from the oils used.

The data obtained are of a preliminary or screening nature. The fact that a consistent material may be obtained with certain soaps and oils after 60 double strokes of the grease worker should not necessarily be interpreted to be proof that a practical grease has been obtained, but rather should be interpreted as preliminary evidence of some compatibility of the soap and oil.

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TABLE V -CALCIUM BASE PRODUCTS

Oil			Aniline	
No.	VI	v.g.c.	Point °F	Consistency and Nature
I	97	.810	230	See *(1) below
2	98	.803	259	See *(1) below
3a	96.7	.806	241	See #(2) below
3h	96.8	.803	251	See #(2) below
4a	46	.865	182	220
4b	68	.841	206	240
5a	46	.904	143.6	275
5b	32	.859	174.2	265
5e	57	.845	- 222.8	See #(2) below
5d	70	.819	234.7	See *(1) below
ба	9	.892	152	245
6b	30	.859	177	345-a grainy slurry, all soap suspended
60	57	.837	208	240
6dq	60	.825	225	290
7a	87.5	.807	226.8	See #(2) below
7b	93.1	.805	233.2	See *(1) below
7c	64.6	.844	204.8	375—a grainy slurry, all soap suspended
8	81.5	.786	215.8	280
9a	72	.838	189.9	280—grainy
9b	80.6	.826	199.4	265—grainy
9c	96.5	.805	221.8	See *(1) below
10a	45	.859	178	215
10b	62	.858	194	240
Ha	91	.814	224	See \$(2) below
11b	78	.836	196	235
12a	92	.826	217.8	See =(2) below
12b	114	.793	230	See #(2) below
13	82	.772	224	250

Codes: \*(1) - Made no grease even after addition of 0.5% free fatty acid.

\$(2)—Made a grease after addition of 0.5% animal fatty acids.

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# ACKNOWLEDGMENT

The following companies deserve credit and thanks for providing the lubricating oils used in this work:

California Research Corporation

Carter Oil Company
Cit-Con Oil Corporation
Kendall Refining Company
Oronite Chemical Company
Shell Oil Company
Sinclair Refining Company
Socony-Vacuum Laboratories
Standard Oil Company (Indiana)

Likewise, the manufacturers of the soaps used—notation of the sources having been made earlier in this article—deserve credit and thanks.

TABLE VI-SODIUM BASE PRODUCTS

Oil			Aniline	Consistency and Nature	Consistency and Nature
No.	VI	v.g.c.	Point °F	Na Soap Only	Na Soap Plus Glycerine
1	97	.810	230	X (See 1 below)	X (See 1 below)
2	98	.803	259	X (See 1 below)	X (See 1 below)
3a	96.7	.806	241	280-slight grain	X (See 1 below)
3b	96.8	.803	251	Soap Suspended Fluid when stirred sus	X (See 1 below)
4a	46	.865	182	210	310—Short Fibre—T (see 2) s'ight bleed
4b	68	.841	206	210	grainy—fluid when stirred Grainy—fluid when stirred
5a	46	.904	143.6	275	320-grainy, breaks on stirring
5b	32	.859	174.2	190	295-grainy, all soap suspended
5e	57	.845	222.8	375—grainy breaks on stirring	X (See 1 below)
5d	70	.819	234.7	breaks to fluid on working	X (See 1 below)
ба	—9	.892	152	200	350—slight grain
6b	30	.859	177	195	320—short fibre, some bleed
бе	57	.837	208	220	300-short fibre, slight bleed
6d	60	.825	225	235	380—grainy
7a	87.5	.807	226.8	285—short fibre	X (See 1 below)
7b	93.1	.805	233.2	265	X (See 1 below)
7c	64.6	.844	204.8	270—slight f.bre	360
8	81.5	.786	215.8	260	290—short fibre
9a	72	.838	189.9	190	300
9b	80.6	.826	199.4	215	Short fibre, too soft to test-bleed
9c	96.5	.805	221.8	210	315
LOa	45	.859	178	205	295—short fibre
10Ь	62	.858	194	210	280
Ha	91	.814	224	265	380—grainy mass
Hb	78	.836	196	260	335
12a	92	.826	217.8	195	280—grainy, slight bleed
12b	114	.793	230	200	X (See 1 below)
1.3	82	.772	224	235	X (See 1 below)

Codes: (1) X-Soap separated from oil on cooling.

<sup>(2)</sup> T-Translucent.

# Discussions

# by J. B. STUCKER The Pure Oil Company

Mr. Boner's paper represents the most comprehensive published data on the effect of the mineral oil component of greases that I've seen to date. While we have made enormous strides in the development of the technical theory of greases in the last decade, we are still a long way from the end of the road where we will be able to paper-design a grease to tailor-made specifications in the front office and then go out in the plant and process a ten-thousand-pound batch with no difficulty. However, Mr. Boner's paper certainly covers many miles of that road.

Our Company has had several interesting cases in the past where different mineral oils have made considerable difference in the finished greases. In particular, we have had two cases with lime-base greases using a tallow of approximately the same characteristics as that used by Mr. Boner and in which the processing steps closely paralleled those used by Mr. Boner. In the first case we had been making a limebase grease for many years using a typical 750 vis Gulf Coast pale oil. Due to crude oil shortage we were forced to shift to a different crude source but inasmuch as the pale oil from the second crude showed physical tests practically identical with those on the oil previously used, we made the change without any undue worrying and without advising the grease-maker in the plant. On the very first batch he came into the office with a long face to report that he had lost the batch-it just wouldn't go into a grease. Fortunately we had a grease-plant superintendent with the canny intuition that comes in very handy at times like that and after watching the batch work in the kettle for a few seconds he told the grease-maker to continue the addition of water. The batch finally hydrated just as easily as previous production but it required exactly twice as much water to throw the batch into a grease as we had formerly used.

The second case was one in which the same soap-stock mentioned above was used with a 2000 vis Gulf Coast pale oil. When zero V.I. oil was used the batch went into a grease and could be cut back with no difficulty. However, when 50 V.I. solvent-refined Gulf Coast oil was used, the material was almost impossible to hydrate without the formation of some grain and when an attempt was made to cut the batch back the introduction of as little at five gallons of the oil into approximately 5000 pounds of hydrated material caused the batch to go into a soup-like mass.

On a laboratory scale, the results of our investigation of the use of high V.I. oils are in general agreement with those reported by Mr. Boner. In particular, we have found that the introduction of even small amounts of high viscosity high V.I. oils appear to destroy the gel structure of lime-base greases. With high V.I. oils of lower viscosity, we have found that the presence of glycerine in the grease seems to destroy gel structure. In general, I believe most grease makers will agree that high V.I. solvent-refined oils are not as easy to handle in most greases as were the low V.I. conventionally-refined oils.

# by L. W. McLENNAN Union Oil Company of California

Mr. Boner has indeed made a very brave effort to reduce the field of grease knowledge to a few generalizations. For the most part, we agree with his conclusion regarding the effect of oil composition upon grease properties.

Mr. Boner has a good point, we believe, in suggesting that the aniline point of the oil be used as an index of solvency for soaps. Dipole moments are likely to be misleading. It is interesting to note that benzene has no dipole moment, although regarded as a very good solvent, while hexane, also with no dipole moment, is a relatively poor solvent. Benzene, for example, dissolves barium oleate when water is present, while hexane does not. Neither solvent appears to dissolve the dry soap alone. The aniline point of the oil, therefore, may prove to be a very useful property in relating oil composition to grease properties.

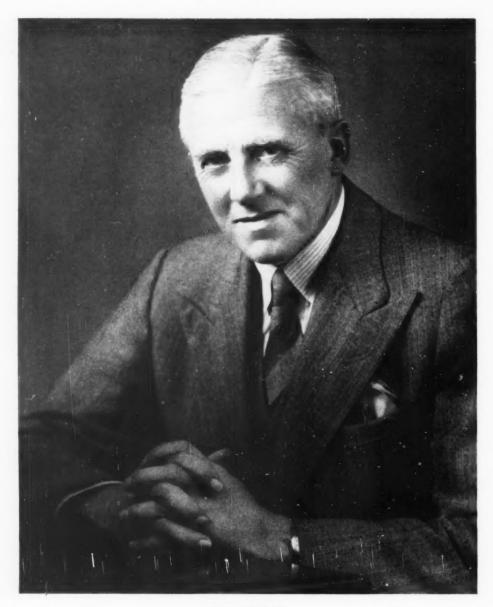
We find it difficult to discuss the relation of oil composition to grease manufacture without being confronted constantly with the marked effects that the conditions of soap formation and finishing the batch may have upon the final product. Similarly the type and the purity of the fat or fatty acid, the presence of water, glycerine, salts, fatty acids, etc., can drastically modify the characteristics of the end product. Mr. Boner, of course, is well aware of these points. Variations in oil composition can be diluted out to a considerable degree by some of these factors. For example, greases of widely varying oxidation resistance can be made with California solvent-treated oil merely by varying the quality of the fat used in producing the soap.

It seem to us that, in dealing with any given type of oil, one of two lines of attack can be taken:

- An empirical method can be employed whereby the different factors, such as type of soap, conditions of soap formation, etc. can be varied, and eventually, the pattern of behavior for the oil can be resolved. This is the common method.
- 2. The basic or fundamental approach can be made whereby a phase rule study can be made with different solvents, and the oil in question eventually related to the particular solvents used in the phase rule study. This of course, requires considerable time and special personnel, but leads eventually to a much more comprehensive understanding of oil behavior. This approach is in line with Dr. Leedy's remarks.

We have re-read Dr. Puddington's 1945 paper referred to by Mr. Boner, and we are also inclined to disagree with Dr. Puddington as to the effect of oil composition on calcium grease structure. However, Dr. Puddington's opinion may be based upon data not evident in his paper.

In conclusion, we believe that Mr. Boner has given an interesting correlation of lubricating oil composition with grease manufacture. At the same time, he has once more emphasized how complex the study of grease is and how much more fundamental or basic knowledge on the subject remains to be developed.



E. A. EVANS

"Grease ... has not received the attention it must now receive."

# Grease...

# by E. A. EVANS 1950 Presidential Address Institute of Petroleum

Notwithstanding the able brains and the picturesque work which has been applied to the elucidation of friction, it still remains obscure. Theories there have been, and theories there will be until the truth ultimately emerges. Obviously, it would be an advantage to know the hidden secrets of the thing which

lubrication is trying to conquer, and must conquer if industry and pleasure are to continue. But, as lubrication has met the needs of man with reasonable success throughout the ages, a litttle delay in the elucidation of friction will not affect seriously economic progress. Oils and greases have attained a standard comparable to the demands made upon them, and it is reasonable to suppose that normal engineering development will not outpace lubrication. Of course, new inventions are always liable to cause economic disturbances of some sort, but it is not long before equilibrium is restored. The hypoid gear created consternation when it was invented, but the chemist was soon on the trail with extreme-pressure lubricants. More recently, the jet engine has taxed the mind of the engineer as we! as the chemist, but not in vain. The more complex a machine becomes the greater must be the precision of its components if the whole is to run in perfect harmony. Obviously, the lubrication must be as perfect as the structure.

Substances which are in universal and urgent demand are

likely to be the subject of detailed scientific examination, so long as attention is focused on their economical production and use. It is not surprising, therefore, that in Great Britain and the U.S. a study of lubrication has been eagerly pursued. The progress which has been made has brought us to the state at which any new lubricant must show early promise

if it is to succeed. Grease, however, has not received the attention which it must now receive.

In my Presidential Address last year I stated that the original term "grease" was usually restricted to those soft fats in the tissues of animals, which are solid or nearly so

at temperatures not greatly exceeding that of the living animal. So, when soap greases became articles of commerce, they were called "hard greases."

In those days grease was made from tallow or palm oil rendered alkaline with soda or lime water. Soon it became a product made from every available fat, oil, wax, asphalt, rubber, cork, asbestos, ivory dust, hair, or sawdust. Grease was just grease. But, by 1880, grease was made of tallow, sodium or potassium soap, and a minor quantity of mineral oil. Twenty years later it became mineral oil to which calcium or sodium soaps were added. Calcium soaps were used more frequently than the sodium soaps. Then, with the introduction of rosin acids, grease became rosin thickened with lime, or less frequently litharge and mineral oi'. These greases often contained 20 per cent of water and a little sawdust to stop gear rattle.

Such greases having so litt'e hope of attaining glory or admiration, it was sufficient to have an approximate idea of their rheological properties, so the consistency test of Legler' was introduced. The consisto-

meter was a pointed glass rod fitted with a scale pan, and supported by a spring. Weights were applied until the rod penetrated the grease to a depth of 1 cm.

Later came the drop point first suggested by Pohl. It was the temperature at which a smear of grease on the bulb of a thermometer started to flow or drop off. When Ubbelohde

Elliott Alfred Evans was originally trained as a chemist and then turned his interests to chemical engineering. In 1915 he became Chief Chemist to C. C. Wakefield & Company, Ltd., and has retained that post in the Wakefield Group of Companies. At the end of February, 1951, he retired to become Consultant.

He has been a member of the Institute of Petroleum for over thirty, years. In 1946 he became a Vice-President of this organization and from 1948 to 1950 he was President. He has served on many committees of its Council and has been Chairman of several. As a member of the Institution of Automobile Engineers, of which he was elected a Vice-President immediately prior to its amalgamation with the Institution of Mechanical Engineers, he had been particularly associated with the work of the Automobile Research Committee of the LA.E. For his paper on "Extreme Pressure Lubrication" he was awarded the Crompton Medal of the LA.E. for the Session 1942-1943. He is now Chairman of Mechanical Engineers, to which he was elected for the Session 1950-1951. He was actively engaged in the planning of, and presented a paper to the General Discussion on Lubrication, organized by the Institution of Mechanical Engineers in 1937.

He has been a Member of the American Chemical Society for many years and, through his Company, is an affiliated Member of the Society of Automotive Engineers. He has visited America on a number of occasions, so he is well known to the American Society for Testing Materials, the Society of Automotive Engineers and the American Petroleum Institute.

He is well known for his pioneer work on anti-oxidants and as one of the foremost experts on additives for lubricants, and as the author of a standard work, "Lubricating and Allied Oils".



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. . . those words, spoken by a redoubtable seer nearly 2000 years ago, have probably never been so pertinent as they are today. For today's most carefully computed prediction is liable to prove completely false tomorrow. We certainly are not attempting to prophesy anything, but are simply keeping "our noses to the grindstone." And by that we mean doing all we can to continue providing top quality stearates to the grease industry . . . as we have done for years.

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re-designed the test, he enclosed the grease in a small glass cup with a hole in the bottom through which the grease could flow when it reached a particular temperature. In 1909, Gillett adopted a modification of the well-established capillary-tube method used for melting-point determinations. He inserted a glass tube 0.4 cm internal diameter, and 8 cm long, into the grease, so that a plug of grease 1 cm long was left in the tube. The tube was then immersed in water and heated. When the grease began to rise the temperature was noted as the melting point.

The Standardization Committee of the Institute chose the Ubbelohde apparatus for consideration, and after standardizing its dimensions, adopted it as a standard test in 1935.

The large quantity of water which was present in the greases led Marcusson' to suggest a quantitative estimation by boiling the grease with xylene to expel the water, which can be condensed and measured. The Dean and Stark method is a variation of the Marcusson method.

The greases of bygone days were used only for unimportant forms of lubrication. But, when Stribeck and Hertz, at the Ammunition Factory, Berlin, gave an impetus to ballbearing design, a demand for a better grease arose. Ball bearings give rolling friction against sliding friction in plain bearings. Hertz, however, showed that compression of the ball takes place, and that point contact is expanded into a measurable area over which sliding occurs.

Fortunately, the balls rotate about two axes; consequently, there is constant change of surface. The spinning effect may be of the order of one revolution in one direction and six hundred in another. The precision of such bearings made it necessary to exclude abrasive matter and influences likely to lead to rust. A wall of grease is an effective barrier against dirt intrusion and a protection against rust. As speeds and loads increased and designs varied grease-making improved.

But, just as the bubble of improvement was swelling nicely it was pricked by the shortage of fats in the second world war. The grease-maker, deprived of some of his favourite materials, had to turn with rapidity, under the stress of war, to readily available material. Fortunately, recovered grease from the wool-washing areas proved to be a satisfactory raw material for grease-making. The shortage of fats and the variety of fats has deflected attention to a more serious inquiry into grease production. At the present time scientific research is growing in intensity.

The fats from which greases are made are combinations of fatty acid with a trihydric alcohol, glycerol; waxes are fatty acids combined with a monohydric alcohol, of which cetyl alcohol is an example. Natural fats also contain phosphatides consisting of fatty acids, glycerol, and a nitrogenous base.

Although the number of fatty acids found in Nature is considerable, the number existing in any one fat is very few.

The fatty acids are straight chain, monocarboxylic, and mainly lie within the range of 12 to 20 carbon atoms. Some are saturated, and some unsaturated.

Stearic  $CH_3(CH_2)_{10}$ :COOH Oleic  $CH_3(CH_2)_{7}$ :CH =  $CH(CH_2)_{7}$ :COOH Linoleic  $CH_3 \cdot (CH_2)_{4}$ :CH =  $CH \cdot CH_2 \cdot CH = CH \cdot (CH_2)_{7}$ :COOH Linolenic  $CH_3 \cdot CH = CH \cdot CH_2 \cdot COOH$ 

An approximate separation of the solid or saturated fatty acids can be made from liquid or unsaturated acids by saponifying, separating the acids, converting them into their lead salts, and fractionating with ether.

In general, the saturated acids are mainly found in animal fats, and unsaturated acids in vegetable oils. The division is not clear-cut, as palmitic acid exists in quantity in palm oil, and lauric acid in kernel fats. Marine oils are largely unsaturated

In addition to the glycerides, fats contain unsaponifiable matter. Coconut contains 0·2 to 0·4 per cent, olive up to 1·5 per cent, whale up to 4 per cent, and wool grease up to 50 per cent. Some oils contain almost 100 per cent of an unsaturated terpene hydrocarbon, squalene,  $C_{30}H_{50}$ . Cholesterol  $C_{47}H_{45}$ OH, occurs as aan ester in wool grease

Although solid or semi-solid fats come from warm-blooded animals, the melting point of the fat is lowered as the position from which the fat is obtained approaches the skin, the extreme case being fluid neatsfoot, which is obtained from the feet. No such variation, however, occurs in human beings or hens. Whether this can be attributed to clothing or feathers is not known. The experiment of covering a pig with a fur coat to provide it with warmth did not alter the melting point of its fats. Diet and locality can influence the properties of fats, for example, pigs fed with whale oil produce a fat which quickly goes rancid.

Refined fats are almost sterile, but if they are not stored suitably they can go rancid through the presence of bacteria and moulds. Moisture is particularly liable to promote the growth of organisms. The disadvantage of rancidity, apart from color and odor, is that the organisms attack the fatty acids by  $\bar{\beta}$ -oxidation, in which they lose two carbon atoms at each successive stage and so lead to the formation of lower fatty acids.

# R·CH<sub>2</sub>·CH<sub>2</sub>·COOH → R·CO·CH<sub>2</sub>·COOH R·CO·CH<sub>3</sub>·COOH → R·COOH

Saturated acids are very stable (Fig. 1); in fact, they have withstood the conditions in Egyptian tombs for several thousand years, but unsaturated acids are prone to oxidation.

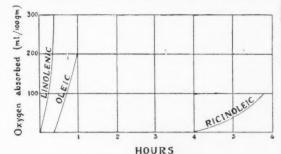
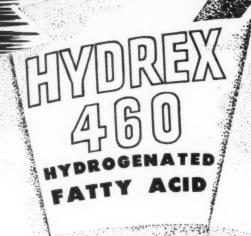


Figure 1
Relative Rates of Oxidation of Unsaturated
Fatty Acids at 95° C.\*



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# STABILITY

### **HYDREX 460 SPECIFICATIONS**

 Titre
 (134.6-140.0 °F) 57.0-60.0 °C

 Color 514" Lovibond Column (max)
 4 Yellow-0.4 Red

 Iodine Value (Wijs)
 1-4

 Free Fatty Acid (as oleic)
 100-103%

 Acid Number
 199-205

 Saponification Value
 201-207

Our hydrogenation process makes it possible in regular production runs to reduce the proportion of unsaturated compounds to a minimum . . . greatly improving the stability of the fatty acid and the end product.

For example, Hydrex 460 Hydrogenated Animal Fatty Acid is a water-white, stable, saturated fatty acid that is relatively rich in stearic acid (about 70.0%), with about 30% palmitic acid and practically free of oleic acid. Yes, with our hydrogenation technique, we are producing high melting point, low iodine value fatty acids with controlled composition. Manufacturers of fatty acid esters, metallic stearates, special lubricants and other products where stability is essential, should investigate medium-priced Hydrex 460 Hydrogenated Animal Fatty Acid.



FACTORIES: DOVER, OHIO TORONTO, CAN.

The presence of a hydroxyl group in the ricinoleic acid accounts for its greater resistance to oxidation.

Ricinoleic acid

CH<sub>3</sub>(CH<sub>2</sub>)<sub>3</sub>·CHOH·CH<sub>3</sub>·CH=CH(CH<sub>2</sub>)<sub>3</sub>·COOH

Elaidic acid, which is the *trans*-modification of oleic acid, is many times more resistant than oleic acid, due to the better screening of the ethylene linkage

 $HC(CH_2)_7 \cdot CH_3$  $HC(CH_2)_7 \cdot COOH$   $CH_3(CH_2)_7CH$  $HC(CH_2)_7\cdot COOH$ 

cis-oleic. trans-oleic or elaidic.

The position of the double bond is likewise important. When it is at the remote end of the molecule it is less easily attacked.

This very brief survey of fats is necessary to comprehend the story of grease. There is nothing new in it. It can all be found in the literature. Every one of the fatty acids found in Nature is a potential raw material for grease.

Grease is a mixture of soap and mineral oil. The soap is made either from fats or fatty acids obtained from fats, consequently, the number of acids which enter into the composition of the soaps is limited to a few. The grease-maker knows how to make grease from fats and commercial fatty acids, but there appears to be little information available about the making of grease from pure acids and the effect of mixtures of fatty acids in known proportions. The reason may be that pure acids are difficult to separate, and commercial acids are far from pure.

It must not be imagined that all soaps will form grease. Lawrence stated that soaps are very peculiar things. One of their still unexplained properties is that with oil they form grease. He believed that only those soaps which do not melt sharply to isotropic liquids gelate in oil. Earle was, however, inclined to place limitations on this suggestion. The difficulty about grease-making is that most soaps are insoluble in oil, but when they are heated with oil they pass through physical changes until finally they melt and dissolve in the oil. On cooling they pass through the same phases and the soap comes out of solution. Pure calcium stearate segregates from oil suddenly at 119° C.

There seems to be some evidence\* that a physical change occurs in sodium stearate at 70° C, as indicated by a small change in specific volume, specific heat, and dielectric constant. Thermal energy is playing its first part in loosening the lattice. Between 125° and 130° C another change in the mesomorphic state occurs. At 125° C, it suddenly becomes plastic. At this temperature the hydrocarbon chains attain a maximum of freedom of motion in two dimensions, but the soap is still held together by the polar bonds of the soap.

At  $240^{\circ}$  C it melts with complete disruption of the polar bonds in the lattice. When considering the initial change which occurs at  $70^{\circ}$ C it is interesting to remember that stearic acid melts at  $70^{\circ}$  C.

Most greases are made at a temperature below the melting point of the soap, but above the transition point from plastic to gel state. Lawrence believes that when soap is heated with oil the lattice opens and oil enters. He also believes that, on cooling, sodium and aluminium soaps crystalize into very small crystals, giving the grease a paste-like structure. Therefore, if there are insufficient crystals, oil will separate. The crsytals may be côlloidal in size in any of the three dimensions. Calcium soap forms a gel which is approaching an homogeneous elastic system.

As it is frequently stated that grease is a colloidal solution, it may be useful at this stage to re-state that a colloid is a particle  $1_{\mu} - 1_{\mu}$  m<sub> $\mu$ </sub> in size. It should not be regarded as a special group of substances, but rather as a group with defined dimensions. They are characterized by high ratio of surface to mass, which accounts very largely for their properties.

Sodium-soap grease is usually made by heating the soap with a mineral oil to a high temperature. If the mass is cooled rapidly a gel or solid block is obtained, depending upon the amount of soap present. In the cold block is a mass of tiny crystals of soap which hold the oil mechanically. If the mass is cooled slowly and with agitation a fibrous structure is obtained, due to the fine fibrils building up into bigger structures. Any method of pulling out the fibres serves to parallelize or orientate the fine fibrils into a larger fibre. The process is akin to combing cotton fibres into a condition which can be twisted into yarn. Even passing the grease through a capillary has a similar effect.

It should not be imagined that all sodium-soap greases can be orientated in this way, nor that they are all fibre forming. Sodium soap made from pure stearic acid is nonfibre forming.

Non-fibre forming Ca—mixed fats
Ca—mixed fatty acids
Na—stearic acid
Al—stearic acid
Na—mixed fats.

From this observation is appears that glycerol and/or unsaturated acids are necessary to make sodium soap fibre forming

Calcium grease, whether made from mixed fats or mixed fatty acids, has a smooth texture, due no doubt to the high

TABLE I.

	-		Swelling
Soap	Visc. sec.	Oil, V.I.	temp, °C.
	300	95	125
Na stearate	300 .	70	120
Na stearate	300	40	120
	1200	95	120
	300	95	105
Na oleate	300	70	. 90
iva oleate	300	40	75
	1200	95	60-65

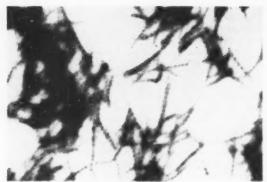


Figure 2
Ordinary electron microscope picture of a calcium stearate grease (X 20,000)

degree of dispersion of the soap crystals and extremely short fibres.

To make a good sodium grease it must be heated until a partial disruption of the soap molecule occurs and then cooled sufficiently slowly for recrystallization of the soap. In the absence of glycerol there seems to be some evidence that mineral oil does not wet the soap, consequently, short fibres are obtained. In the presence of glycerol the soap is dispersed at a lower temperature, and longer fibres result. The length of the fibre is dependent upon the quantity of glycerol present.

A grease-maker knows that if he wishes to increase the fibre he introduces rape oil into his mix. But does he realize that its true purpose is to introduce an unsaturated acid? An unsaturated acid has a marked effect upon lengthening fibre.

Mineral oil also can exercise an important part in fibre length. When sodium stearate is thoroughly dispersed in min-

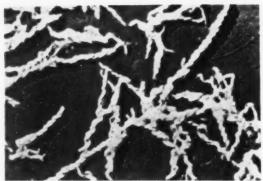


Figure 3

Shadow electron micrograph of sample of a grease similar to Figure 2 (X 35,000); shadows are cast by chromium molecules.

eral oil and heated, swelling occurs. The swelling temperature depends upon the oil used (Table 1).

Whatever may be the viscosity or the V.I. of the mineral oil, it does not affect the swelling temperature of the sodium stearate. But a change of V.I. has a marked effect upon sodium oleate.

Now consider the effect of V.I. upon fibre length Table II.

The fibre length of sodium stearate is very little affected either by changes in V.I. or viscosity, whereas sodium oleate is affected by both.

Sodium stearate in a 95 V.I. oil shows very little increase in viscosity even when heated to  $205^{\circ}$  C, and on cooling produces no fibres. With a 40 V.I. there is a sudden increase in viscosity at  $160^{\circ}$  C. When the heating is continued to  $205^{\circ}$  C, and cooled, fibres of moderate length are formed. But when glycerol is present even with the stearate long fibres are produced.

TABLE II.

TABLE	11.	
Soap	Oil	Fibre length
Oils of same visc (500 sec), varying V.I.:	V.I.	
	95	Very short
Na stearate	70	Little longer
	40	Still longer
	95	Fairly long
50% Na stearate, 50% Na oleate	70	Longer
	40	Very much longer
	Visc. sec.	
Dils of same V.I. (95), varying viscosity:		
	500	Very short
Na stearate	300	Very short
	100	Longer
	500	Fairly long
50% Na stearate, 50% Na oleate	300	Longer
	100	Still longer
Dils of low (40) V.I. and 100 sec visc:		
50% Na stearate, 50% Na oleate	100	Very long
Na oleate	100	Longest

Should it be necessary to produce extra long fibres the addition of phenol is often useful. Resorcinol shortens the fibre, and hydroquinone destroys it. This is important to those who might be contemplating adding a phenolic antoxidant. The action of phenols on aluminium stearate varies considerably in low-boiling-point petroleum spirits. O-Cresol, 2:4- and 2:5-xylenols are weak peptizing agents, whilst phenol is powerful. In general, there is a decrease with each additional methyl group. Further, if the methyl group is in the ortho-position to the hydroxyl group it has the greatest influence in reducing the peptizing power of the phenol. Dihydroxyphenols and pyrogallol have a marked peptizing action. The power increases with the number and proximity of the hydroxyl groups.

Most greases require a peptizer to stabilize them, very much in the same way that emulsions require a third substance to stabilize them. Greases, however, are not emulsions; they are definitely solid soaps dispersed by peptizers in oil. The common peptizers are water, glycerol, fatty acid, but there are many more from which a selection can be made for specific reasons. For calcium grease, wool-fat alcohols, glycerol monostearate, triethanolanine, and glycols are suitable. These, in addition to castor oil and  $\beta$ -naphthol, can be used with aluminium grease. It is claimed that aluminium stearate will stabilize calcium grease, but there is the possibility that the responsibility belongs to the free stearic acid which is usually attached to it. The use of too much peptizer may result in liquefaction of a grease.

The effect of fatty acids is not uniform. In small amounts oleic acid prevents gelation of sodium oleate in pinene, but when the quantity is increased the system sets to a firm transparent gel which does not synerize. With stearic acid the system does not set to a gel even when the acid content is varied over a wide range. Small quantities of palmitic acid retard syneresis, and if the amounts are increased the system gives a loose, viscous mass instead of a rigid gel. Benzene and toluene retard, while xylene and mesitylene accelerate syneresis. There appears to be a relationship between the number of methylene groups and the retardation or acceleration of syneresis.

Even soaps have effects upon other soaps.18 Soaps in ad-

Fibres of Sodium Laurate are not only interwoven, but actually grown together.16

mixture affect syneresis. Of course, it has long been known that calcium and sodium soaps will soften an aluminium grease.

With the advent of the electron microscope (Fig. 2 & 3) fresh revelations have been made.14 Confirmation has been found that a stabilizer must be present in calcium grease. If it is water, the calcium-soap fibres twist into a rope-like structure. When the water is expelled it untwists and finally loses its structure. To ensure a twist there must be 1.3 per cent of water. When the water content falls to 1-1 per cent untwisting commences, and when it reaches 0.4 per cent all the structure has disappeared. If water is added to the dehydrated grease, twisting recurs, and if the water content is increased to 2.4 per cent the fibres lengthen, but do not widen. The fibres can be torn apart by working. What causes the twist is not known, although stirring may be a contributory factor. Perhaps one could postulate that the work on the structure of fibres at Leeds University will assist in elucidating such interesting yet difficult problems. It has been shown that calcium acetate converts the amorphous dry soap into fibres, but they are not twisted. It seems to assemble the fibres into bundles. For effective structural stabilization, calcium acetate and water must be present in molar concentrations approximately equal to or greater than that of the soap. When fibre disintegration occurs, syneresis follows. Since this work was published, evidence has been collected from X-ray-diffraction patterns that anhydrous calcium stearate can exist in three different structures depending upon the rate of dehydration.18

The electron microscope has also revealed that the fibres of sodium laurate (Fig. 4) are not only interwoven, but actually grown together.\(^{10}\) The fibre junctions give rise to many capillary spaces in which water or oil can be retained. The characteristically curved formation of sodium laurate is not common for all sodium soaps, as sodium palmitate is generally straight. The fibres of soaps are built-up structures of soap molecules in double rows with the carboxylate groups together (Fig. 5).

The molecules, however, are not long, thin things with a long hydrocarbon chain attached to a carboxylate group. Sodium laurate is only three times as long as it is broad,

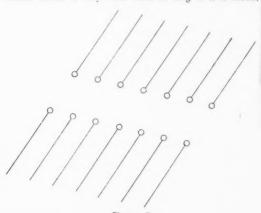


Figure 5
The fibres of soaps are built-up structures of soap molecules in double rows with the carboxylate groups together.

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and sodium stearate has a length five times its width.

For many years there has been controversy about the stability of aluminium grease and the existence of mono-, di-, and tri-aluminium soaps. The objective is to prepare the soap which gives the greatest stability in oil. Some aluminium greases are particularly prone to liquefy on ageing. It is claimed by some obsessivers that the di-soap produces the most satisfactory grease, therefore a satisfactory method for making it is welcome.17 If potassium soap is added to a large excess of an aqueous solution of aluminium chloride the di-soap is produced, but it is usually associated with 20 to 30 per cent of free or loosely attached fatty acid which is extractable with anhydrous solvents, leaving the di-soap. If the precipitation of the laurate soap is done at 25 to 30° C free floating flocs of aluminium dilaurate are formed which are easily washed. When the temperature exceeds 40° C a sticky soap is formed which on cooling sets to a hard, brittle mass, though both appear to be the same chemically and both melt at 195° to 197° C. Whereas the distearate forms a slow filtering mass when precipitated at 50° to 60° C, when precipitated at a high temperature it is a fine powder. Whether the subject has really been finalized it is difficult to say.18

An aluminium salt which has a remarkable thermal stability is aluminium dicyclohexane carboxylate, Al(OH)- $(C_nH_{11}COO)_2$ . It melts at 450° C with decomposition.

The structure of aluminium stearate is not known, but opinions have been expressed that it is a polymer bound by weak intermolecular links, " which may harmonize with the fact that aluminium grease can lose consistency when fed from a grease-gun.

That there is something peculiar to aluminium stearate is exhibited by the curious behaviour observed, that if a disc is maintained stationary and parallel to the base of a rotating beaker containing a solution of aluminium stearate in petrol, so that the solution completely covers the disc, there is an upward thrust at right angles to the direction of rotation, and that there is a flow from the rim of the disc inwards, also at right angles to the main direction of rotation. Further, the solution tends to climb the rod holding the disc stationary. This penomenon was not observed with other types of colloids which were tried.<sup>20</sup>

It is hoped that the facts collected in this address will be of service to the grease-maker in directing his investigations. Now that it has been proved that soaps exist in more phases than liquid, plastic, and crystalline, added attention will have to be given to the significance of them in grease operation. It may be found that these several phases owe their origin to traces of water. But it will also be necessary for somebody to determine the working temperature of the grease at the point of lubrication.

Grease formation is essentially the phenomenon of gelation of soaps in oil. After gelation, partial crystallization may be accompanied with cooling, but the gelation seems to be essential for getting the soap adequately dispersed as a thickening agent. At some elevated temperature the soap passes from a gel into a true solution and ceases to thicken it usefully, whereas at a lower temperature segregation of the soap occurs. The conventional method of preventing the syneresis has been the addition of small amounts of water or glycerol without understanding the nature of the process. This peptization of the soap by

these means stabilizes at normal temperatures, but unfortunately lowers the gelation temperature, thereby restricting the operational-temperature range.

By a greater discrimination of the fatty acids used it is possible to widen the temperature range of the gel state. The effect of the metalkation of one soap on another soap has received some attention. Although the commercial possibilities have not yet been established, the mixing of kations is promising. Provided the soap has a high enough gelation temperature, peptizing agents containing a polar group have the greatest appeal in spite of their chemical activity and liability to encourage corrosion.

That controlled syneresis should occur is held by some to be essential to efficient lubrication, whilst by others that syneresis should not occur. In fact, a test has been introduced which implies that a calcium grease shall be virtually free from syneresis at a temperature higher than that at which dehydration occurs, or that temperature at which structural changes take place. From this it will be apparent that a fundamental research is necessary to establish whether lubrication is due to free oil or grease. Obviously, uncontrolled oil separation is undesirable.

The importance of physical tests will not be denied, nor can one underestimate the need for mechanical tests, but until the scientific build-up of grease has been more perfected there is the possibility of using bench tests like bromides as a substitute for action. Many of the shortrange twists and turns have been born of expediency. It is now time that the mixture of interests should combine together into a compound.

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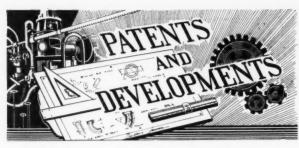
Red Lead Pipe Thread Lubricant Locomotive Pressure Gun Grease Electric Motor Bearing Lubricant Incubator Bearing Lubricant Concrete Pump Lubricant Air Conditioning Equipment

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### EXTREME PRESSURE LUBRICATING GREASES

An extreme pressure lubricating grease composition has been described in a recent patent issued to Standard Oil Development Company (2,540,534) which contains the alkaline earth metal salt of a high molecular weight sulfonate in conjunction with alkaline earth metal salts of a low molecular weight alkyl sulfonic acid and a low molecular weight carboxylic acid. The presence of salts of low molecular weight carboxylic acids in such a mixture imparts considerable extreme pressure properties. This effect is apparently due to the activation at high loads of the sulfur present in the sulfonate, which action allows the formation of a metallic sulfide film which is evidenced by a black film appearing upon the wear area with which the grease comes in contact.

The low molecular weight carboxylic acid salt is preferably calcium acetate, although any of the alkaline earth metal salts of low molecular weight carboxylic acids such as formic, acetic, propionic, butyric, oxalic, furoic, and lactic may be used.

These greases contain about 10% to 30% by weight of total salts. The weight ratio of the high molecular weight sulfonate to the low molecular weight sulfonate plus carboxylic acid salt is about 1:0.4 to about 1:1.25. The low molecular weight constituents are employed in weight ratios of sulfonate to carboxylic salt of from about 0.8:1 to about 7.5:1. A good grease, for example, can be prepared containing 5 to 20% of high molecular weight sulfonate, 2 to 6% low molecular weight sulfonate and 2.5 to 7.5% low molecular weight carboxylic acid salt.

One example given contains the following:

10% strontium sulfonate

5% calcium acetate, anhydrous

3.5% ethanesulfonic acid

1.5% hydrated lime

85.0% acid extracted coastal mineral oil,

55 S. U. S./210° F. viscosity.

In the preparation of this grease the free ethane sulfonic acid was dissolved in twice its weight of water and was neutralized with the hydrated lime. When the reaction appeared to be complete, the neutralized solution was added to a blend of the strontium sulfonate and the mineral oil and the batch was stirred at 180° to 200° F, until no solid particles were present. Then the calcium acetate was added as a 20% aqueous solution and the product dehydrated slowly, with stirring, until a temperature of 300° F, was reached. The product was cooled to room temperature without stirring and was easily homogenized to a smooth grease structure.

### SULFONATE GREASE

Sulfonate grease containing a mixture of calcium and lead salts of a low molecular weight aliphatic carboxylic acid have been found to possess superior properties according to a Standard Oil Development Co. Patent 2,540,533. Greases prepared from high molecular weight sulfonates and low molecular weight acid salts show extreme pressure properties superior even to those of greases which contain extreme pressure additives. According to this patent, these extreme pressure properties may be considerably enhanced by the substitution of a part of the calcium salt by a lead salt.

The amount of the sulfonate present in the finished grease may range between 0.5% by weight for soft greases, up to about 50% by weight in the extremely hard greases, although a range of 5 to 20% by weight is preferred.

The low molecular weight carboxylic acid which may be reacted with the calcium or lead to form the calcium or lead salt may be acetic acid, oxalic acid, propionic acid, or lactic acid. Of these, acetic acid is the one preferred.

As an example, 20% of a 50% concentrate of the strontium salt of a petroleum sulfonic acid is dissolved in an acid treated coastal distillate of 55 SUS viscosity at 210° F, at a temperature of about 150° F. A 20% aqueous solution of calcium acetate in sufficient quantity to introduce the desired amount of calcium acetate is added and the batch is partially dehydrated at 200° F. The lead acetate is then added as a 30% solution, after which the batch is dehydrated at 240° F, and placed in an oven at 300° F, for 2-3 hours to finish the dehydration.

The claims specify a grease containing 5 to 20% of a strontium petroleum sulfonate of 300-600 molecular weight with about 10% of a mixture of lead and calcium salts of an acid selected from the group consisting of low molecular weight aliphatic carboxylic acids having not more than 6 carbon atoms, said mixture containing 2.5% to 7.5% by weight of the calcium salts and about 7.5% to 2.5% by weight of the lead salts.

### FOREIGN PATENTS

British

650,798 (Electro-Hydraulics, Ltd.)—Reciprocating grease pumps.

651,339 (Texaco Development Corp.) — Preparation of normal barium soap grease compositions.

# GREAS-EVENTS

Here is a feature you can reproduce in your own publication. An electro can be made from this drawing to fit your particular page. Tell the story of your industry in picture form.



Chairman T. G. Roehner, Director of the Technical Service Department, Socony-Vacuum Laboratories

Reports at the meeting of ASTM Technical Committee G held in Washington, D.C., February 5-6, 1951, showed that that group is still making important progress in developing improved methods for testing lubricating greases. Among the subjects discussed were the following:

- 1. Write-up of a method to cover an accelerated test for grease on copper.
- 2. Development of a method for determining the total lead content of greases.
- 3. Revision of the scope of ASTM Method D-128-47 to show that it is limited to analyses of normal or conventional type greases.
- Write-up of the method covering the use of the Motorized Grease Worker for obtaining penetrations of lubricating greases worked more than 60 strokes.
- Steps to advance Method D-1092-50T, "Apparent Viscosity of Lubricating Greases," to a Standard.

- 6. Progress on the development of a perforated disc for obtaining the consistencies of semi-fluid greases.
- 7. Revision of Method D-972-48T, "Evaporation Loss of Lubricating Greases," to cover tests at temperatures up to 300°F.
- 8. Organization of a clinic to study techniques for obtaining starting and running torque data on greases at temperatures of  $-40^{\circ}$ F, and  $-65^{\circ}$ F.
- 9. A survey in which three ball bearing greases will be tested by seven cooperators using the so-called GE and Navy testers.
- Study of screening methods for evaluating ball bearing greases, particularly the AFBMA method employing the BEC machine.
- 11. A survey to determine whether corrections of variations in the design of the present wheel bearing grease testers, plus differences in interpretations of the language of the method will result in sufficiently satisfactory reproducibility and repeatability to warrant reissue of the method on a tentative basis.
- 12. Selection of a new series of greases to study the merits of the AN-G-5a type procedure for evaluating the water resistance properties.
- 13. Organization of the Fretting Corrosion Symposium to be held at the June 1952 ASTM meeting.

The Chairman and Secretary of ASTM Technical Committee G are, respectively:

Mr. R. C. Adams, U. S. Naval Engineering Experiment Station.

Mr. Gus Kaufman, The Texas Company.

They will welcome any comments regarding the above activities.

# ABOUT THE COVER

(Continued from page 4)

The first large-scale HYDRO-FOL ACID production began in 1931. As the demands of the grease and stearate manufacturers became more specific, additional grades of HYDROFOLS were developed. Today, you can obtain a HYDRO-FOL ACID made to almost any specification you need—and as always, the composition will be guaranteed.

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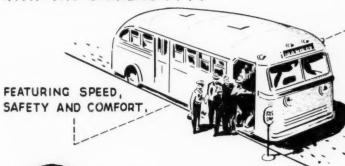
# Greas-Events

LONDON .... 1829

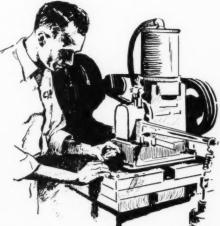
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ACTUALLY, TODAY'S BUS COULDN'T RUN MUCH FASTER THAN THE 18:39 CONTRAPTION . . . . IF A MODERN RESEARCH CHEMIST WORKING IN A PETROLEUM LABORATORY HADN'T DEVELOPED A LUBRICATING GREASE TO WITHSTAND THE SPEED AND WEIGHT OF MODERN AXLES.

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OREASE NEATER 1

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cooks and cools ingredients for grease on a

3-minute time cycle. And one man can supervise the job.

That's because VOTATOR Grease-making Apparatus processes continuously—always under precise, automatic control. Time-consuming, labor-taking batch methods can be eliminated. Moisture content can be controlled accurately; grease delivered for packaging at the proper temperature.

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GIROLER

Votator Division

# GREASONALITIES



Wallace Linville
Managing Editor
Petroleum Educational Institute

# PETROLEUM EDUCATIONAL INSTITUTE JOINS N.L.G.I.

The Petroleum Educational Institute, recently accepted member of the N.L.G.I., was organized in 1934. For two years, weekly classes were conducted with 20 to 25 groups of from 10 to 30 men, who at the time were engaged either in the sale or service of petroleum products in the automotive or industrial fields.

These groups studied the weekly assignments on a home study basis and the examination papers were handed in at class discussion time. From these discussions was gathered the material for compiling the course that was first published in 1937 as a non-technical home study course covering the Funçamentals and Application of Fuels and Lubricants.

When students complete the course they are asked to offer suggestions on how the text could be improved. These suggestions are filed and carefully considered when revising the course. The work was revised in 1940, 1945, and 1950. With each revision the number of illustrations has been increased and this

will be continued until the assignments have become virtually a set of picture books.

The complete course for automotive and industrial salesmen consists of 25 assignments. For service station personnel there is a 10-assignment course. From these 35 assignments are compiled special courses in either fuels or lubricants. By deleting the Industrial Section the 25 assignment course becomes a study in automotive fuels and lubricants. All assignments can readily be understood by anyone having only a grade school education. Upon enrollment the student receives 5 assignments and thereafter, one each week. Executives are advised when their men are enrolled and when they complete the course.

Students are expected to complete a minimum of one assignment each week to maintain class requirements. On this basis it requires 6 months to complete the course for automotive and industrial salesmen. Executives receive periodical reports showing the progress of each man. When in arrears of class requirements, students are notified. Upon completion students receive a hand lettered Certificate of Graduation.

In most cases the tuition is paid or shared by employers, usually through a reimbursement plan after the student completes the course. In some cases the tuition is paid by the employer and charged back to the student if he does not complete the course within a reasonable period. The percentage of completions is over 70%.

At present over 500 marketers including majors, independents, and jobbers are recommending the course to their sales and service personnel.

Administration affairs are directed by G. A. Zamboni, and the editorial department is under the supervision of Wallace Linville.



G. A. Zamboni Managing Director Petroleum Educational Institute



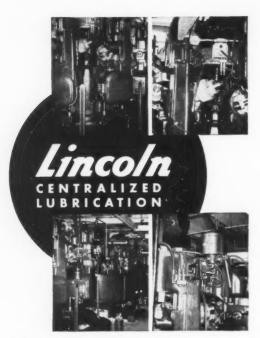
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Made in the pure, dark grades especially for the grease maker, highest quality Penn-Drake Petrolatums will help maintain the uniformity and superiority of your products. They are refined from 100% pure Pennsylvania Crude and will not melt or become runny. May we send samples?

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Butler, Pa.



# "Reduces Down-Time... Increases Operating Hours"

at Detroit Gear Division, Borg-Warner Corporation

The Detroit Gear Division of Borg-Warner Corporation recently completed an extensive-equipment and plant remodeling program to produce a new automatic transmission for a leading automobile manufacturer.

To have a minimum amount of "down-time" and a maximum amount of "operating time," Lincoln Centro-Matic\* Lubrica-tion was installed on eight Station Cleveland Riggid Hobbers. Results were so satisfactory that the System was extended to the Bullard Production Machines. Again, the results led to the installation of the Lincoln System to a large battery of newly purchased Holcroft Heat Treating Furnaces. According to L. A. Schnitzer, Maintenance Superintendent of Detroit Gear Division, results from Lincoln's

- Centralized Lubrication are: \*1. Positive automatic lubrication for all bearings at predetermined intervals
- "2. Lubrication while machines are in operation
- "3. Complete lubrication of machines in a matter of one or two minutes, with visual indicator at each point of lubrication
- "4. Avoids costly machine breakdown time."

Lincoln's lubrication system specialists will work with you and recommend the time and money saving Centralized Lubrication System best suited to your equipment.

On Old or New Equipment LINCOLN'S Centralized Lubrication Systems

PROVIDE THE RIGHT LUBRICANT. IN THE RIGHT QUANTITY, AT THE RIGHT TIME

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No. 9 Niles Pail with lug cover and pour spout.

# NILES STEEL PAILS

ordinarily are supplied with bail handles. Fabricated from black steel-outside painted or lithographed to order. Removable tops with lug covers, with or without pour spouts. Also in tight head style. 31/2 to 6 gallon capacities.

# NILES STEEL DRUMS

55, 30 and 15 gallon capacities; and 100 lb. grease drums. Full open head or Bung type. Painted or fully decorated. Interior lacquered if desired.



Grease Drum with 14 inch full open top lug cover. Also made Also made with 9 inch lug cover in center of head.



NILES STEEL PRODUCTS DIVISION REPUBLIC STEEL CORPORATION - NILES, OHIO The Editorial and Advisory Staffs which assist in the preparation and proof reading of text consist of E. C. Emmons, G. French, U. B. Brea, C. R. Stewart, L. J. Grauder and E. W. Templin.

The Institute is a member of the National Home Study Council and its work has been approved by the Veterans Administration for Veterans, who can secure the complete training at government expense.

In the final stages of preparation is the new PEI Journal, a monthly publication which will be devoted exclusively to the interest of sales and service personnel. It will also serve to keep students up to date on current, new and changing developments.

A manuscript has been started on a course at an engineering level. This advanced work will cover the same subject matter covered in the non-technical course, but with a greatly expanded industrial section.

T. Nicholas Bath
Chief Lubrication Engineer
Battenfeld Grease and Oil Corp.

### T. NICHOLAS BATH JOINS BATTENFELD

T. Nicholas Bath has accepted the position of Chief Lubrication Engineer for the Battenfeld Grease & Oil Corporation. The announcement was made by Battenfeld's president, Mr. A. J. Daniel, on March 1st when Mr. Bath assumed his new duties.

Mr. Bath has had a long and distinguished career in the petroleum industry. He graduated from the University of Illinois in 1929 with a degree in Chemical Engineering. He served as a chemist for the Pennsylvania Petroleum Company and the Kansas City Testing Laboratories before joining the Shell Oil Company in 1935. When he left Shell Oil in 1950 he was Assistant Manager of the Lubrication Department in charge of nation-wide industrial lubrication sales.

# FOWLER JOINS STAFF OF MIDWEST RESEARCH INSTITUTE

Dr. Frank C. Fowler, formerly of the University of Oklahoma faculty, has been added to the staff of Midwest Research Institute, Kansas City, Missouri, as petroleum consultant, it was announced by Dr. M. H. Thornton, chairman of the Institute's chemistry division.

Fowler attended the universities of Illinois and Michigan, and was awarded the Ph.D. degree from the latter school in 1943.

He will conduct investigations in petroleum and allied fields for the Institute. This activity has been initiated as a result of numerous industrial requests for assistance in this field.

"The addition of Dr. Fowler to our staff should expand our present facilities for research and development work in petroleum, another phase of our industrial program undertaken in the interest of better utilization of natural resources," said Dr. Thornton.

From 1943 to 1946, Fowler was senior process engineer in the chemical products department at Phillips Petroleum Company, Bartlesville, Oklahoma. At the university since 1946, he administered both graduate and undergraduate courses, and directed graduate research. He also conducted industrial research programs for the University of Oklahoma Research Institute.

Fowler has published numerous technical papers, and is a member of the American Institute of Chemical Engineers, American Chemical Society, Sigma Xi, and Alpha Chi Sigma, national chemistry fraternity.

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George E. Missbach N.L.G.I. Company Representative for Morehouse Industries

### MOREHOUSE APPOINTS N.L.G.I. REPRESENTATIVES

Morehouse Industries was founded in Chicago in 1898 and later moved to Los Angeles. For many years they have been engaged in the manufacture of grinding and dispersing equipment for industry, including paint, printing ink, food—and now grease.

The plant at 1156 San Fernando Road, Los Angeles, is equipped with the very latest in all types of machining tools for the production of their highly specialized equipment.

George E. Missbach of Atlanta has been appointed to membership in the N L.G.l. and Glenn H. Morehouse will be the company's technical representative to the Institute. George Missbach joined Morehouse in 1947, and is in charge of domestic and Canadian sales. Glenn Morehouse is the third generation Morehouse with the company, which his grandfather founded. He is in charge of the development laboratory at Los Angeles.



Glenn H. Morehouse N.L.G.I. Technical Committee Representative for Morehouse Industries



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Port Arthur, Tex.—Fort Worth, Tex.
Sweetwoter, Tex.

### \*1951 - FUTURE MEETINGS OF YOUR INDUSTRY \*

### **APRIL, 1951**

- 16-17 A.S.T.M. (Committee D-10 on Shipping Containers), Atlantic City, New Jersey.
- 16-18 American Socy. of Lubrication Engineers (annual convention and lubrication show), Bellevue-Stratford Hotel, Philadelphia, Pa.
- 16-18 Socy. of Automotive Engineers, Inc. (aeronautic meeting and aircraft engineering display), Hotel Statler, New York, N. Y.
- 18-20 National Petroleum Assn., Hotel Cleveland, Cleveland, Ohio.
- 23-24 Industrial Accident Prevention
  Assns. (annual accident prevention convention), Royal York
  Hotel, Toronto, Canada.
- 25-26 Indiana Independent Petroleum Assn. (spring convention), Oliver Hotel, South Bend, Ind.
- 29 to May 2 American Assn. for the Advancement of Science (Southwestern division), Texas Western College Campus, El Paso, Tex.
- 30 to May 1 Chemical Specialties Mfrs. Assn. (37th mid-year meeting), Hotel Drake, Chicago, Ill.
- 30 to May 2 Chamber of Commerce (39th annual meeting), Washington, D. C.
- 30 to May 3 American Petroleum Institute (Safety and Fire Protection Committees, 4th mid-year meeting), Mayo Hotel, Tulsa, Okla.

### MAY, 1951

- 1-3 The American Oil Chemists' Socy. (spring meeting), Roosevelt Hotel, New Orleans, La.
- 6-8 Pennsylvania Petroleum Assn., Inc. (annual spring convention), Bedford Springs Hotel, Bedford, Pa.

- 7-8 Independent Petroleum Association of America (mid-year directors meeting), Cosmopolitan Hotel, Denver, Colo.
- 7-11 National Fire Protection Assn. (annual meeting), Hotel Statler, Detroit, Mich.
- 13-16 American Inst. of Chemical Engineers (regional meeting), Hotel Muehlebach, Kansas City, Mo.
- 20-22 Empire State Petroleum Assn., Inc., Hotel Statler, Buffalo, N. Y.
- 21-24 Oil Industry Information Committee, Brown Palace Hotel, Denver, Colo.
- 28-29 American Petroleum Institute
  (Division of Marketing, General & Lubrication Committees) (midyear meeting), Netherland Plaza
  Hotel, Cincinnati, Ohio.
- 28-June 6 Third World Petroleum Congress, Kurhaus, Scheveningen, Holland.

### JUNE, 1951

- 3-8 Socy. of Automotive Engineers, Inc. (summer meeting), French Lick Springs Hotel, French Lick, Ind.
- 4-6 American Gear Manufacturers Assn. (annual meeting), The Homestead, Hot Springs, Va.
- 11-15 The American Society of Mechanical Engineers (semi-annual meeting), Royal York Hotel, Toronto, Canada.
- 14-15 Pennsylvania Grade Crude Oil Assn., Hotel William Penn, Pittsburgh, Pa.

18-22 American Socy. for Testing Materials (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.

### AUGUST, 1951

13-15 Socy. of Automotive Engineers, Inc. (west coast meeting), Olympic Hotel, Seattle, Wash.

### SEPTEMBER, 1951

- 3-7 American Chemical Society (120th national Diamond Jubilee meeting), Hotel Statler, New York, N. Y.
- 5-8 Oil Industry Information Committee, Waldorf - Astoria Hotel, New York, N. Y.
- 6-7 Michigan Petroleum Assn. (annual fall convention), Ramona Park Hotel, Harbor Springs, Mich.
- 8-9 International Union of Pure and Applied Chemistry (16th conference), Hotel Statler, New York, N. Y.
- 10-13 International Congress of Pure & Applied Chemistry (12th conference), Hotel Statler, New York, N. Y.
- 11-13 Socy. of Automotive Engineers, Inc. (tractor meeting), Hotel Schroeder, Milwaukee, Wisc.
- 12-13 A.P.I. Lubrication Committee, Atlantic City, New Jersey.
- 12-14 National Petroleum Assn., Hotel Traymore, Atlantic City, N. J.
- 14-15 International Union of Pure and Applied Chemistry (16th conferance), Hotel Statler, Washington, D. C.

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### WOOL GREASE FATTY ACIDS

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Moisture	2%
Unsaponifiable (Wooi Grease Alco	hols) 5%
Saponifiable	95%
Free Fatty Acid (as aleic)	84%
Actual Free Fatty Acid Content	95%
Free Inorganic Acid	0.32%
Free Neutral Fat	None
Saponification Value	170
Iodine Value	25
Apparent Salidification Point (tit	re) 42 C.
Softening Point	45 C.
Sulphur	0.1%
AOC	Mathade



Power House · Shop

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Automotive Uses



SINCLAIR REFINING COMPANY
630 Fifth Avenue, New York 20, N.Y.

25-28 The American Socy. of Mechanical Engineers (fall meeting), Radisson Hotel, Minneapolis, Minn.

### OCTOBER, 1951

- 8-10 The American Oil Chemists' Socy. (fall meeting), Edgewater Beach Hotel, Chicago, III.
- 8-12 National Safety Council (39th national safety congress and exposition), Stevens Hotel, Chicago, Ill.
- 13-14 Indiana Independent Petroleum Assn. (fall convention), Hotel Severin, Indianapolis, Ind.
- 14-20 Oil Progress Week.
- 29-31 N.L.G.I. (annual meeting), Edgewater Beach Hotel, Chicago, Ill.

### NOVEMBER, 1951

3-8 Oil Industry Information Committee, Stevens Hotel, Chicago, Ill.

- 5-8 American Petroleum Institute (31st annual meeting), Palmer House, Chicago, Ill.
- 5-8 A. P. I. Lubrication Committee, Chicago, Illinois.
- 25-30 The American Society of Mechanical Engineers (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.
- 26 to Dec. 1 23rd Exposition of Chemical Industries, Grand Central Palace, New York, N. Y.

### DECEMBER, 1951

- 2-5 American Inst. of Chemical Engineers (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.
- 3-4 Chemical Specialties Mfrs. Assn. (38th annual meeting), The Mayflower, Washington, D. C.



### JUNE, 1952

- 9-10 Chemical Specialties Mfrs. Assn. (38th mid-year meeting), Hotel Statler, Detroit, Mich.
- 23-27 American Socy. for Testing Materials (annual meeting), Hotel Statler, New York, N. Y.

### OCTOBER, 1952

20-24 National Safety Council (40th national safety congress and exposition), Stevens Hotel, Chicago, Ill.

#### NOVEMBER, 1952

30 to Dec. 5 American Socy. of Mechanical Engineers, New York, N. Y.

### DECEMBER, 1952

- 1-6 20th National Exposition of Power & Mechanical Engineering, Grand Central Palace, New York, N. Y.
- 8-9 Chemical Specialties Mfrs. Assn. (39th annual meeting), Hotel New Yorker, New York, N. Y.

# UNOBA the original <u>multi-purpose</u> lubricant



# Proved under the most critical operating conditions

Originated and developed by Union Oil Company of California, UNOBA grease is the industry's original multipurpose lubricant that resists both heat and water. These outstanding heat and water resistant properties of UNOBA are due to the use of a barium soap base—a patented Union Oil Company discovery.

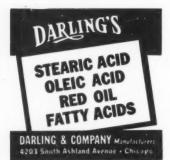
Today, multi-purpose UNOBA is solving severe lubricating problems in every branch of industry—under the widest range of operating conditions.



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GREASE MAKERS
ALUMINUM STEARATE
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Cottonseed Fatty Acids
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Stearic & Oleic Acids



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### LUBRICATE WITH "TOUGH" GREASES ALL YEAR 'ROUND

One casy stroke of hand lever dispenses Lithium, Barium and heavy solds-base greases in coldest weather. Heavy-duty Gir-2-Alber (its 2-5. to 40-lb. standard grease because the control of the control of

Precision workmanship-fully guaranteed.

WRITE FOR FOLDER AND PRICE

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LUBRICATE FOR SAFETY EVERY 1,000 MILES

# NEWS About Your Industry



Cross-section view of Chaffee Disc Disperser shows how the material is pushed up by the screw feed from the intake pipe and passes through the first perforated plate, then by the first set of rolating knives, and so on through the series of alternating plates and knives.

### CHAFFEE ANNOUNCES NEW DISC DISPERSERS

Announcement of the new Chaffee Laboratory and production Disc Disperser Models with exclusive shearing knives has been made by the Chaffee Design & Manufacturing Co., East Aurora, N. Y.

# FISKE BROTHERS REFINING CO.

Established 1870

NEWARK, N. J. TOLEDO, OHIO

Manufacturers of

LUBRICATING GREASES Both of these new models are equipped with perforated plates with the same size holes through which the emulsion is forced with feed screw pressure. This design feature makes it possible for both the Chaffee Laboratory and Production Models to produce identical products. In other words, the emulsion that is produced on a test basis in the pilot model can be duplicated exactly in the production model. Between each of the perforated discs, specially designed shearing knives revolve at very high speed.

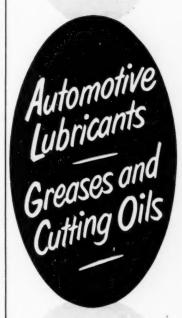
This combination of discs and knives provides positive shearing action on the emulsion instead of the usual tearing that generates a terrific amount of frictional heat. Chaffee Disc Disperser does not require any cooling apparatus due to small amount of heat that is generated with this knife and disc arrangement during the dispersing operation.

The Chaffee Disc Disperser was developed for grease manufacturing but has wide application with slight modification in other industries using emulsions.

The increase in operational performance and efficiency is reflected in the use of much smaller motors than is customarily required by dispersing operations in grease-making including dispersing bentones.

For complete information on both models of Chaffee Disc Dispersers, write the Chaffee Design & Manufacturing Company, East Aurora, N. Y., for fully-illustrated catalog.

LUBRICATE FOR SAFETY EVERY 1000 MILES Laboratory improved and tested



PENOLA OIL COMPANY OIL COMPANY 15 WEST SI ST., NEW YORK 19, N.Y.

# Silicone News Silicone Fluid QUINTUPLES Bearing Life!



ESY BREESE BURNERS, INC.

Bearings of Breese Drafbboster Fan motor oil furnaces are lubricated with Dow Corning 200 Silicone Fluid to give years of trouble-free service.

Breese Burners, Inc. of Santa Fe, New Mexico, manufactures the Drafbooster. one of the most efficient fan motors available for oil-fired furnaces. Featuring quality materials and expert design, the Drafbooster still required a complete oil change every year. Unfortunately, despite careful instructions, few customers bothered with this chore. After two or three years, the oil became so badly oxidized and carbonized that the entire unit frequently had to be replaced.

Then Breese engineers heard about Dow Corning 200 Silicone Fluid. They subjected a sample to the breakdown tests designed to evaluate the mineral oils they had been using.

The silicone fluid worked perfectly, showing no sign of deterioration. Drafboosters containing Dow Corning 200 were then put on lifetime field tests under the most severe operating conditions. Careful checks showed that the silicone fluid was still as good a lubricant after five years of service as it was originally. As a result, Breese promptly standardized on Dow Corning 200 Fluid for the bearings in all Drafboosters. That was 21/2 years ago. Over 33,000 Drafboosters have been put in service since then. Not a single unit has ever been returned because of lubrication failure. For more information about Dow Corning Silicone Fluid, call our nearest branch office or write for your free 33-page

### DOW CORNING CORPORATION MIDLAND, MICHIGAN

booklet N-3.

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### **EMERY OPENS NEW OFFICE**

Emery Industries, Inc., announces the opening of a direct sales office at 221 N. LaSalle Street, Chicago, on April 1, 1951. The rapid development of specialized products requiring technical sales and service through direct sales coverage is indicated as the reason for the new

E. G. Hibarger, formerly Cincinnati District Manager, has been appointed

Chicago District Manager in charge of the new Emery Industries Office. D. R. Robertson, currently specialty sales representative in the Chicago area, and A. R. McDermott have been appointed to the Chicago district as chemical sales representatives.

The district to be served by the new sales office includes northern Illinois, northern Indiana, Wisconsin, Minnesota and northern Iowa.



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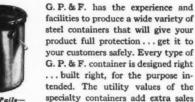
appeal to your product.



Standard Grease Pails—25, 35, and 50-lb, sizes.



Pouring Pails-2 to 61/2 gals.





G. P. & F. Steel Containers are finished in solid colors, or lithographed with your own design. Hot dipped galvanized, tinned or terne coatings are also available. Can be ordered in straight carloads, mixed carloads or smaller quantities.



F.Z Fill Gree



Dome-Top Util-ity Cans—2, 3, 5-gal. and 40-lb. sizes.

It's Better to Ship in Steel



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Half Bushel Basket —Hot dipped galva nised, 30-lb. capacity



Pouring Drums-Self-venting and standard spouts 2 to 6 gals.





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PETROLEUM ADDITIVES FOR EVERY PURPOSE



Corrosion inhibitor for distillate fuels

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Inhibitor-detergent combinations for premium and heavy-duty service

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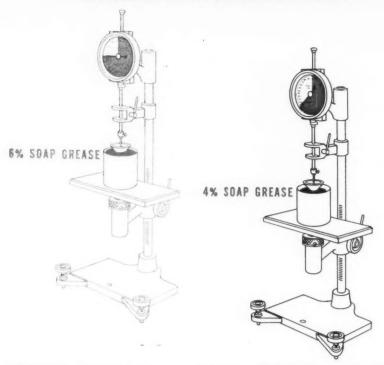
521, 522

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Further Information will be sent upon request. MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1700 So. Second St., St. Louis 4, Mo.

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